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CARBON TETRACHLORIDE

(CAS 56-23-5)

SCOPE OF THE DOCUMENT

This document focuses on the hazards of carbon tetrachloride. The toxicity, fire, explosion hazards, and reactivity of this chemical are described. Procedures for first aid, exposure control, storage, handling, spill and leaks are also detailed. Information relevant to the workplace is emphasized.

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CARBON TETRACHLORIDE - CHEMICAL HAZARD SUMMARY NO. 41

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I. MAIN CONCERN

Carbon tetrachloride can cause severe kidney and liver damage. Moreover, based on animal data, there is a serious concern that it may cause liver cancer in humans.

II. OCCUPATIONAL EXPOSURE

Carbon tetrachloride is a volatile, colourless liquid with a sweetish unpleasant odour.

Currently, carbon tetrachloride is used mainly as a starting material in the manufacture of Freons. It is also used, to a lesser degree, as a solvent in laboratories, as a refrigerant and as an agricultural fumigant. Its use as an industrial solvent has decreased during the last few years because of its potentially severe health effects. Prior to concerns about its health effects, carbon tetrachloride was used extensively in metal degreasing, dry cleaning and fire extinguishers.

The main routes of occupational exposures are inhalation of the vapour and absorption through intact skin.

General information on routes of exposure is available in the CCOHS publication "How Workplace Chemicals Enter the Body."[1]

III. HEALTH HAZARDS

Removal from the Body

About half of the carbon tetrachloride absorbed by the body is exhaled unchanged. The remainder is broken down and then excreted in the urine and feces. It takes about two to three weeks after the exposure has stopped for the body to completely eliminate carbon tetrachloride.

Consumption of alcoholic beverages as well as exposure to other alcohols, such as isopropyl alcohol, can increase the toxic effects of carbon tetrachloride on the liver.

Effects of Short-Term Exposure in Humans

Inhalation

Exposure to carbon tetrachloride vapour concentrations as low as 25 to 30 parts per millions (ppm) can cause harmful effects on the central nervous system. Symptoms may include headache, nausea, dizziness, vertigo, depression, mental confusion, lack of coordination, vomiting, abdominal pain and diarrhea.

Brief, intense exposures have caused liver and kidney damage. Damage to the kidneys causes problems with blood pressure which, in turn, can affect the heart. Heart failure may result from extensive kidney damage.

Very high concentrations (about 1000 to 2000 ppm) can cause loss of consciousness and death.

Eyes

Carbon tetrachloride vapours can be slightly irritating to the eyes. Contact with the liquid may also cause irritation.[2]

Skin

Carbon tetrachloride liquid may cause skin irritation. Its ability to remove the protective natural oils of the skin may cause reddening and cracking of the affected area.

Ingestion

Small amounts of carbon tetrachloride may slightly irritate the gastrointestinal tract. Large amounts may cause severe liver and kidney damage.

Effects of Long-Term Exposure in Humans

Skin

Repeated or prolonged exposure to liquid carbon tetrachloride can lead to recurrent inflammation of the skin (dermatitis). Toxic amounts of the liquid can be absorbed through intact skin.

Eye

Repeated exposure to carbon tetrachloride is suspected of causing damage to the optic nerve which affects vision. The symptoms have included blind spots, reduced visual field and blurring.[2]

Liver

Repeated exposure to carbon tetrachloride can damage the liver and reduce its effectiveness in detoxifying other chemicals such as alcohols. The result may be an increased susceptibility to the toxic effects of other chemicals.

Kidney

Repeated exposure to carbon tetrachloride can cause severe damage to the kidney. Secondary to kidney failure, there may be heart failure and death.

Reproductive Effects

Although carbon tetrachloride can cross the placental barrier and reach the fetus, there are no reports of effects on the fetus.[3]

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Cancer-Causing Effects

Liver tumours have been reported in a few cases following carbon tetrachloride exposure. The International Agency for Research on Cancer (IARC) states that, based on animal experiments and human case reports, "it is reasonable, for practical purposes, to regard carbon tetrachloride as if it presented a carcinogenic [cancer-causing] risk to humans."[4]

The American Conference of Governmental Industrial Hygienists (ACGIH)[5] has also classified carbon tetrachloride as a "suspected human carcinogen."

Toxicity Data in Animals and Laboratory Tests

Lethal Dose Values

The poisoning strength of a compound can be estimated from the LD_{50} or LC_{50} obtained in animal tests. LD stands for lethal dose, LC for lethal concentration in air. The LD_{50} is the amount of a chemical (weight of chemical per weight of animal) which is needed to kill one-half (50 percent) of the test animals. The LC_{50} is the concentration in air which kills one-half of the animals following an exposure lasting 4 hours or other indicated time period. LC_{Lo} is the minimum concentration of a chemical necessary to kill one animal in an experiment. Test animals are usually rats, mice or other rodents. Routes of exposure are usually by mouth (oral), through the skin (dermal) or by breathing in the airborne chemical (inhalation). The values obtained for this material by different researchers are:

- LD_{50} (rat, oral): 2800-2920 mg/kg
- LC_{Lo} (rat, inhalation): 4000 ppm/4 hours
- LD_{50} (rat, skin): 5070 mg/kg

On a scale of 1 to 6, where 1 is practically non-toxic and 6 is super toxic, the acute poisoning potential of this chemical rates as 3 (moderately toxic).[6]

General information on the LD_{50} is available in the CCOHS publication "What is an LD_{50}?"[7]

Other Animal Data

Chronic Inhalation

Rats, rabbits and guinea pigs exposed to 25 ppm of carbon tetrachloride for 7 hours a day, 8 days a week, for up to 6 months, showed some liver problems. Slight changes in the liver were seen in animals similarly exposed to 10 ppm while repeated exposures to 5 ppm essentially caused no effects.[8]

Reproductive Effects

Rats were exposed to 300 ppm and 1000 ppm of carbon tetrachloride for 7 hours daily, between day 6 and day 15 of pregnancy. They produced fetuses weighing less than expected. However, this effect may be due to the toxic effects on the mother. This study also showed that high levels of carbon tetrachloride did not cause birth defects (teratogenicity) or spontaneous abortion.[3,4]

In summary, there is limited evidence that, in animals, carbon tetrachloride is not teratogenic but, at high doses, may be toxic to the fetus.[3]

IV. FIRE AND EXPLOSION HAZARDS

Carbon tetrachloride does not burn but it decomposes at high temperatures (such as in a fire). Decomposition produces highly toxic and corrosive gases and vapours such as chlorine, hydrogen chloride and phosgene.[9]

V. CHEMICAL REACTIVITY

Carbon tetrachloride is normally stable but it can react violently with fluorine, sodium, potassium, aluminum and some other reactive metals.[9]

VI. EXPOSURE LIMITS

Many Canadian jurisdictions have exposure limits similar to those established by the American Conference of Governmental Industrial Hygienists (ACGIH). The following exposure limit has been established by ACGIH for carbon tetrachloride:

Eight hours/Time weighted average: 5 parts per million or 30 milligrams per cubic metre.

"Skin": Absorption by the unbroken skin, eyes or mucous membranes may contribute to the overall exposure.

The ACGIH has listed carbon tetrachloride as a "suspected human carcinogen" in Appendix A2 of the TLV booklet.[5]

Contact the appropriate authority in your jurisdiction for details of the specific regulations which apply. Refer to ACGIH documentation for information on the setting of this exposure limit.[10]

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VII. EXPOSURE CONTROLS

Engineering Controls

Engineering control methods to reduce hazardous situations are preferred. These methods may include mechanical ventilation (dilution and local exhaust), process or personnel enclosure, control of process conditions, process modifications and administrative controls.

Because of the high potential hazard associated with carbon tetrachloride, stringent control measures such as process enclosure or isolation may be necessary in addition to local exhaust ventilation. Use a ventilation system separate from other ventilation systems and exhaust the contaminated air directly to the outside (do not recycle). Supply sufficient replacement air to make up for the air removed by the exhaust ventilation systems.

In some work situations, engineering controls and work practices may not be effective in controlling exposure to carbon tetrachloride. In such cases, use suitable personal protective equipment including respiratory protective devices. In addition, ensure that appropriate protective equipment is available in case of emergencies such as spills or fire.

Respiratory Protection

If respiratory protection is required, a complete respiratory protection program should be instituted. This program must include selection, fit testing, training, maintenance and inspection. Refer to the CSA Standard Z94.4-M1982, "Selection, Care, and Use of Respirators."[11]

The US National Institute for Occupational Safety and Health (NIOSH) has recommended the following respiratory protection for carbon tetrachloride vapour concentrations:[12]

- At any detectable concentration: Self-contained breathing apparatus with a full face piece and operated in a pressure-demand or other positive pressure mode.

  Supplied air respirator with a full face piece and operated in pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.

- Escape: Air purifying full face piece respirator (gas mask) with a chin-style or front- or back-mounted organic vapour canister.

  Appropriate escape-type self-contained breathing apparatus.

These recommendations apply only to NIOSH and MSHA (Mine Safety and Health Administration) approved respirators.

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NIOSH has classified carbon tetrachloride as a potential occupational carcinogen, according to specific NIOSH criteria. This classification is reflected in their recommendations for respiratory protection. The requirements in Canadian jurisdictions may vary.

Eye/Face Protection

Wear chemical safety goggles to avoid contact with the liquid. In addition, a face shield may be necessary to protect the face.

Skin Protection

Since carbon tetrachloride can penetrate intact skin, skin protection is necessary. Wear gloves, coveralls and boots made of NBR, VITON or polyvinyl alcohol (PVA). Note that the resistance of specific materials can vary, and, therefore, resistance under actual working conditions should be evaluated. Strict maintenance of protective clothing is also required.

VIII. STORAGE AND HANDLING

Store carbon tetrachloride in a cool, dry, well-ventilated area, out of direct sunlight, away from incompatible materials and heat. Store in suitable, labelled containers, and keep them tightly closed when not in use or when empty. Protect containers from damage. Use suitable storage tanks, buildings, rooms or cabinets. Store a limited quantity of the chemical and limit access to the storage area to authorized personnel. Post warning signs on the potential hazards of carbon tetrachloride. Use a storage area separated from the work areas and inspect it periodically for deficiencies such as damaged containers or leaks.

Wear appropriate personal protective equipment when using carbon tetrachloride. Use minimal quantities of the chemical in designated areas where ventilation is adequate. Avoid generating mists or vapour. Use approved portable containers for solvents in the work area.

Ensure that suitable emergency equipment for fires, spills or leaks is readily available. Do not use carbon tetrachloride near welding operations, flames or hot surfaces since, in such cases, it can decompose to give off toxic vapours and gases.

Dispose of empty containers properly. Empty containers may be hazardous if residual carbon tetrachloride is present.

IX. FIRST AID

The following first aid procedures are recommended in case of exposure to carbon tetrachloride.

General Provisions

Take proper precautions to ensure a safe rescue. Remove the source of contamination if this can be done safely or transport the victim to fresh air. Provide general supportive measures to the victim such as comfort, warmth and rest.

Inhalation

If breathing has stopped, immediately begin artificial respiration or, if the heart has stopped, cardio-pulmonary resuscitation (CPR). Obtain medical attention immediately.

Eye Contact

Flush the contaminated eye(s) immediately with lukewarm, gently flowing water for at least 20 minutes, holding the eyelid(s) open. Ensure the contaminated water does not touch the non-exposed eye. If irritation persists, obtain medical attention immediately.

Skin Contact

Avoid direct contact with the chemical. Wash the contaminated area of the skin as quickly as possible with lukewarm, gently flowing water for at least 20 minutes. Under running water, remove all contaminated clothing, shoes and leather goods (such as watchbands, belts). If irritation persists, obtain medical attention immediately.

Ingestion

Never give anything by mouth if the victim is unconscious, rapidly losing consciousness or convulsing. Do not induce vomiting. Have the victim drink 240-300 ml (8-10 oz.) of water to dilute the chemical in the stomach. If vomiting occurs naturally, have the victim lean forward to reduce the risk of breathing liquid carbon tetrachloride back into the lungs, and repeat the administration of water.

If the victim's breathing has stopped, immediately begin artificial respiration or, if the heart has stopped, cardio-pulmonary resuscitation (CPR). Transport the victim to an emergency facility as quickly as possible.

Additional Comments

Adequately trained personnel only should perform rescues and first aid procedures. A physician or the nearest Poison Control Centre should be consulted for all exposures except minor instances of inhalation or skin contact. All first aid procedures should be reviewed periodically by a physician familiar with carbon tetrachloride and its conditions of use in the workplace.

Decontaminate clothing, shoes and other leather goods completely before reuse, or discard. Notify the laundry facilities of the nature of the hazards.

X. CLEAN-UP AND DISPOSAL

An emergency action plan should be prepared in advance and appropriate training should be provided. Emergency equipment should be readily available and in good working order. The emergency area should be restricted to authorized personnel until the completion of the clean-up. Only trained personnel who are provided with adequate personal protective equipment should conduct the clean-up.

Contact the manufacturer or the supplier of the chemical for advice. Notify the appropriate government occupational and environmental agencies.

Ventilate the area and remove all sources of heat or flame to prevent the formation of hazardous products.

Take up small spills with an absorbent material which does not react with carbon tetrachloride, such as sand or vermiculite. Place contaminated absorbent in suitable, covered, labelled containers for disposal. Flush the area with water.

Contain a large spill with earth, sand or other inert material. It may be feasible to pump the liquid into suitable covered, labelled containers for disposal. Absorb the remaining product with an inert absorbent material and put into suitable, covered, labelled containers for disposal. Flush the area with water.

Note: The contaminated absorbent poses the same potential hazards as the spilled product.

Review all federal, provincial and local government requirements prior to disposai. Disposal by incineration or secure landfill may be acceptable.

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Note: Additional references on this subject are available from CCOHS upon request.

PLEASE NOTE

This summary was prepared at the Canadian Centre for Occupational Health and Safety (CCOHS) and is intended primarily as a source of information for persons who work with or may be occupationally exposed to this material. The information selected for inclusion is believed to be reliable and generally relevant to occupational health. Other information which bears on particular work situations may be available. The scientific data in many areas are limited and may allow a variety of interpretations. Additional information, corrections, comments and questions are welcome, and should be addressed to the Inquiries Service, CCOHS, 250 Main St East, Hamilton, Ontario, L8N 1H6, 416-572-2981; toll free 1-800-263-8276.

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